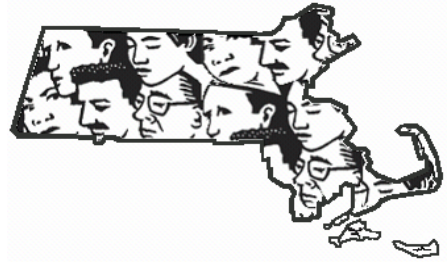


Massachusetts FACE Occupational Fatality Report

Massachusetts Department of Public Health
Occupational Health Surveillance Program
Fatality Assessment and Control Evaluation Project



Carpenter Dies from Carbon Monoxide Poisoning while Using a Gasoline Powered Generator Inside a Construction-site Storage Container - Massachusetts

Investigation: # 06-MA-059-01
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SUMMARY

On December 26, 2006, a 43-year-old finish carpenter (the victim) died from carbon monoxide (CO) poisoning, while he was working inside a metal storage container where a gasoline powered generator was operating. The victim was putting equipment away and completing tasks at the end of the day, after having installed a newel post in a residential home in a new housing complex. The generator was running, providing energy for a light. When the victim did not return home after work and did not answer his cell phone, his wife and her two brothers went to the storage container and found the victim. He had been overcome by CO and had collapsed inside the storage container. A call was placed for emergency medical services (EMS). One of the victim's wife's brothers turned off the generator and pulled the victim out of the storage container. They administered cardiopulmonary resuscitation (CPR). Once EMS arrived the victim was transported to a local hospital where he was pronounced dead. The Massachusetts Fatality Assessment and Control Evaluation (FACE) Program concluded that to prevent similar occurrences in the future, employers should:

- **Always leave fuel-burning generators outside of buildings and storage containers when operating; and**
- **Ensure carbon monoxide detectors are used when fuel-burning generators are running and employees are located at indoor and/or partially enclosed work sites.**

Home builders / general contractors of large construction projects should:

- **Provide electricity at long term tool and equipment storage locations being supplied to subcontractors; and**
- **Ensure that the maps of construction sites provided to local emergency response personnel include all storage locations for materials and equipment.**

In addition, manufacturers of fuel-burning generators should:

- **Provide warnings about the hazards of carbon monoxide associated with fuel-burning generators on labels permanently affixed to the generators, in compliance with Underwriters Laboratory; and**



- **Promote research to develop fuel-burning generators that reduce carbon monoxide emissions.**

BACKGROUND

Carbon monoxide (CO) is a poisonous, colorless, odorless and tasteless gas produced by burning fuel, such as gasoline, kerosene, oil, propane, coal or wood. When fuel-burning equipment, tools and appliances are used in enclosed spaces, or spaces without good ventilation, CO levels can build up quickly and can result in death.

CO is extremely hazardous, because it deprives the body of oxygen and reaches deadly levels without being detected ¹. Estimated deaths from CO in the United States, including those associated with work, have ranged from 109 to 188 per year (1999-2002). Since 1999, the percentage of those estimated CO poisoning deaths specifically associated with generators has increased annually, from 7% in 1999 to 24% in 2002. In the years from 2002 through 2005, the Consumer Product Safety Commission (CPSC) noted 253 non-fire CO fatalities specifically associated with engine-driven tools, of which 218, or 86%, were from generators.²

INTRODUCTION

On December 27, 2006, the Massachusetts FACE Program was notified by a local fire department through the 24-hour Occupational Fatality Hotline, that on December 26, 2006, a carpenter was overcome by CO. An investigation was initiated. On February 15, 2007, the Massachusetts FACE Program Director and an assistant traveled to the home builder / general contractor's office where they met the vice president / project manager for the construction project and discussed the incident and observed the area where several contractors' storage containers were located. The death certificate, and police and fire reports were reviewed. A telephone interview was conducted with the wife of the victim.

The victim was a finish carpenter with 15 years of experience. The victim had worked as a self-employed carpenter for the same home builder / general contractor conducting residential and commercial development on a single, large multi-acre residential project for approximately seven years. Depending on the assignments, over the years, the victim would sometimes hire assistants. He usually worked six days per week, starting at 7:00 a.m., but had only worked several hours on the day of the incident, which was during a six-week layoff due to a decline in residential housing sales. The victim was an experienced and skilled carpenter, and had received an award for outstanding workmanship from the home builder / general contract manager three years prior to his death.

INVESTIGATION

The victim was contracted by the home builder / general contractor as a master carpenter. His tasks included, but were not limited to, installing plywood floors, baseboards, interior trim around windows and doors, and wood stairs. The victim provided his own tools and was one of many contractors working in constructing new residences.

The home builder / general contractor controlled the construction of new units in the complex, including maintaining a permanent office within the complex, hiring trades for all construction activities, mandating requirements for trades to work in this community, and enforcing speed limits on the streets. The home builder / general contractor representative reported that they had a health and safety manual, provided construction safety seminars and sent email safety tips to contractors, and maintained lists of contractors' attendance at training sessions, as well as injuries sustained by contractors and their employees. It was not known if the safety trainings had ever included the hazards of fuel-burning portable generators or CO. Subcontractors were deemed "partners in trade," but not employees.

In order to store tools and materials on-site, most of the larger contractors hired by the home builder / general contractor rented storage containers and parked them in the residential complex, on private land in an area surrounded by a chain-link fence, provided by the home builder / general contractor specifically for the placement of these containers (Figure #1). It was reported that contractors used the containers to store tools and equipment instead of using unlocked homes under construction as a storage location or transporting materials back and forth daily in their vehicles. The victim had rented one of these metal storage containers for this use for the previous couple of years. The metal storage container was 20 feet long, eight feet wide and 12 feet high with double doors on one end, and was located at the far corner of the storage area, adjacent to approximately five others in this area within the complex. During the investigation, the home builder / general contractor's representative reported that they were unaware that the victim had a storage container on-site.

The portable gasoline-powered generator involved in the incident was new when purchased by the victim. The generator was equipped with a 15 horsepower engine, seven gallon fuel tank, and provided 8,000 watts of power (Figure #2). The victim used the generator when he needed to operate electrical power equipment when no electricity was available, such as in the storage container and, at times, in the residences under construction. There were no warnings on the generator regarding the hazards of CO.

The incident occurred during a six week layoff period that was related to a decline in residential housing sales. The victim had not been working during this period but was on-site the day of the incident, the day after Christmas, because the home builder / general contractor asked the victim to install a newel post in a house that had recently been purchased. The task took the victim a few hours to complete. After finishing the task, the victim went to the storage unit to put his tools and equipment away, and complete some tasks. At the time of the incident, the generator was located inside the storage container and turned on, powering a light. The double doors to the storage container were partially open.

The victim had called his wife around 6:00 p.m. to inform her that he would be home soon. At approximately 9:30 p.m., the victim's wife and her two brothers went to look for the victim, retracing his usual route to and from work to see if he had trouble with his truck. When they arrived at the location of the storage container within the complex, they found the victim's pick up-truck with the dome light turned on, but no one inside the cab. They could hear the generator running inside the container. The victim was found inside the storage container lying on the floor. One of the victim's wife's brothers turned the generator off and dragged the victim out of

the storage unit. CPR was administered until EMS arrived. Once EMS arrived, the victim was transported to a local hospital where he was pronounced dead.

On the day of the site visit, both personnel of the FACE project had difficulty finding the location of the storage containers, the location of the incident. This was after looking at a map in the on-site office of the home builder / general contractor and getting verbal directions. This multi-acre residential complex and construction site contains a maze of new roads, many of which are dead ends.

CAUSE OF DEATH

The medical examiner listed the cause of death as inhalation of products of combustion.

RECOMMENDATIONS/DISCUSSION

Recommendation #1: Employers should ensure that fuel-burning generators are placed outside of buildings and storage containers when operating.

Discussion: Never operate fuel-burning generators indoors, near windows or entrances to indoor worksites, or in enclosed or partially enclosed areas where the products of combustion might be drawn into working areas. On construction sites, generators are frequently necessary to provide power for tool operation. But fuel-burning generators are an extremely hazardous source of CO and have caused the deaths of hundreds of people.

The storage container in which the victim was working was 2,880 cubic feet. It is estimated that the 15 horsepower engine would have generated 167,500 mg of CO per minute.¹ Given the size of the storage container, the concentration would have exceeded the Immediately Dangerous to Life and Health (IDLH) concentration of 1,200 parts per million (ppm) in less than one minute. Fuel-burning generators create and emit CO, and when operated in or near an enclosed area the CO concentration can reach lethal levels. The CO level can easily be underestimated by users due to the colorless, odorless, and tasteless characteristics of CO. NIOSH wrote that a 5-kilowatt engine, less powerful than the 8-kilowatt generator in this incident, produces an exhaust CO concentration equivalent to 252 to 572 idling vehicles.

Recommendation #2: Employers should ensure carbon monoxide detectors are used when fuel-burning generators are running and employees are located at indoor and/or partially enclosed work sites.

Discussion: As discussed, fuel-burning generators can emit high levels of CO. Ensuring that fuel-burning portable generators are only operated outdoors (Recommendation #1) will help minimize employees' exposure to CO. Locating a fuel-burning generators outdoors, but proximal to an indoor or partially enclosed work location, could also pose a CO hazard, as products of combustion may infiltrate the work area.

CO detectors provide a means of direct reading of ambient CO concentrations with preset alarm warnings for hazardous concentrations. They should be used whenever a fuel-burning generator

is used as an energy source. CO detectors should be placed between the generator and the nearest workers. Personal CO monitors with alarm functions are also available. CO detectors use both CO concentration and duration of exposure to trigger the sounding of an alarm. Higher concentrations for short durations or lower concentrations for longer durations will both trigger the alarm. Any CO alarm should trigger evacuation of the workplace, shutting down the generator and evaluating the location of the generator.

Recommendation #3: Home builders / general contractors of large construction projects should provide electricity at long term tool and equipment storage locations supplied to subcontractors.

Discussion: The home builder / general contractor provided fenced off private land, within the residential complex to accommodate the placement of long-term storage containers that subcontractors rented to have a place for secure storage of tools and materials within the complex. In this case, there was no electricity supplied to the area where the storage containers were located. Contractors used portable fuel-burning generators at their storage units to provide power for lighting, tool use and materials storage and retrieval. To eliminate the use of portable generators inside the storage containers, which would eliminate the CO hazard, home builders / general contractors, should consider supplying electricity to areas provided for placement of storage containers.

Recommendation #4: Home builders / general contractors of large construction projects should ensure that the maps of construction sites provided to local emergency response personnel include all storage locations for materials and equipment.

Discussion: The residential complex where this incident occurred was large enough to support locating a new fire department substation in the newly developing community. The home builders / general contractor did routinely supply the local fire department updated maps of the construction site's maze of roads to assist during emergency response, although the maps did not show the materials and equipment storage locations.

While it probably would not have affected the outcome in this case, if the routinely updated construction site maps included storage locations for materials and equipment on the worksite it might have assisted the emergency response personnel in locating the victim. In addition, home builders / general contractors should also conduct a safety overview that is shared with local emergency response personnel to ensure that they have knowledge of hazardous materials, scheduled construction activities and methods of access to and egress from all areas on the construction site.

Recommendation #5: Manufacturers of fuel-burning generators should provide warnings about the hazards of carbon monoxide associated with fuel-burning generators on labels permanently affixed to the generators, in compliance with the Consumer Product Safety Commission (CPSC).

Discussion: Despite the history of deaths and injuries from fuel-burning generators, the hazards are still not well recognized. Shortly after this fatality, the CPSC issued a final rule requiring that CO warning labels be displayed on all portable generators and their packaging that are manufactured or imported into the United States (16 CFR 1407). This final rule took effect on May 14, 2007, and can be found at www.cpsc.gov/businfo/frnotices/fr07/pglabelingcorr.pdf.

Manufacturers should take added step to help educate people about CO by also including CO warnings in instruction manuals and on their web sites. In addition, manufacturers should encourage retailers, distributors and rental agents to add the warning labels to generators manufactured prior to May 2007.

Recommendation #6: Manufacturers of fuel-burning generators should promote research to develop generators that reduce carbon monoxide emissions.

Discussion: New CO-free generators have been developed by some manufacturers to generate electricity for boats. These generators use fuel injectors to improve the fuel-to-air ratio and catalytic converters to further reduce CO and hydrocarbons from the exhaust. While not broadly commercially available yet for boats, the technology exists to reduce CO emissions. Manufacturers should promote research to develop generators that emit less CO or provide catalytic converters that can convert CO to carbon dioxide.

In addition, Underwriters Laboratory has issued a proposed standard UL 2201 Portable Engine Generator Assemblies, which calls for research on a number of methods that will protect against CO poisoning: shut-off circuitry in response to a sensor detecting concentration of 400 ppm, catalytic converters, and built-in CO alarms.

References

- 1) National Institute for Occupational Safety and Health (NIOSH), US DHHS, Public Health Service, CDC, 1996. NIOSH Alert: Preventing Carbon Monoxide Poisoning from Small Gasoline-Powered Engines and Tools. DHHS (NIOSH) Publication No. 96-118.
- 2) Consumer Product Safety Commission 16 CFR Part 1407 Portable Generators; Final Rule; Labeling Requirements. Federal Register Vol. 72, No. 8, January 12, 2007.
www.cpsc.gov/volstd/engine/engine.html

Figure 1: Incident location with similar metal storage containers.



Figure 2: Portable gasoline powered generator involved in the incident.



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FATALITY ASSESSMENT AND CONTROL EVALUATION PROGRAM

The Massachusetts Department of Public Health, in cooperation with the National Institute for Occupational Safety and Health (NIOSH), conducts investigations on the causes of work-related fatalities. The goal of this program, known as Massachusetts Fatality Assessment and Control Evaluation (Massachusetts FACE) is to prevent future fatal workplace injuries. Massachusetts FACE aims to achieve this goal by identifying and studying the risk factors that contribute to workplace fatalities, by recommending intervention strategies, and by disseminating prevention information to employers and employees.

Massachusetts FACE also collaborates with engineering and work environment faculty at the University of Massachusetts at Lowell to identify technological solutions to the hazards associated with workplace fatalities.

NIOSH funded state-based FACE Programs currently include: California, Iowa, Kentucky, Massachusetts, Michigan, New Jersey, New York, Oregon, and Washington.

Additional information regarding this report is available from:

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